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REPORT BY AUTOMOBILE MANUFACTURERS ASSOCIATION ON AIR POLLUTION CONTROL DEVICES FOR MOTOR VEHICLES BEFORE THE CALIFORNIA STATE LEGISLATURE

FEBRUARY 16, 1959

TRANSCRIPT OF PROCEEDINGS

SPEAKER BROWN: I am going to let Mr. Rumford, Chairman of Public Health Committee, which has been studying this subject, preside today. Mr Rumford.

ASSEMBLYMAN RUMFORD: Thank you very much, Mr. Speaker, members of the Legislature, distinguished guests. It is with a great deal of pleasure that we have you here in California today to report on the subject of air pollution control devices for motor vehicles, a subject which is of such great importance to the people of the State of California. We have here today the best minds in the country on this subject, and the feeling of the people of the State is that, because of the capabilities of the automobile industry, there is no problem that is unsurmountable. With these few words, I should like to present to you one of America's outstanding manufacturers, a leader in the field of car manufacturing, Mr. Paul C. Ackerman, Vice President of Chrysler Corporation. Mr. Ackerman will introduce the members of his staff and engineers from other corporations, who have come here today through the courtesy of the Automobile Manufacturers' Association. Mr. Ackerman.

PAUL C. ACKERMAN: Mr. Speaker, Chairman of the Committee, members of the Legislature, we are pleased that you extended an invitation to the Managing Director of the Automobile Manufacturers' Association so that we could have this opportunity to come here today to tell you about the many things we have been doing to try to aid in alleviating the smog situation in Los Angeles. We are also pleased that two of your representatives attended the recent meeting of the Society of Automotive Engineers in Detroit. We hope that more

of you will visit Detroit from time to time so that we can show you what we are doing in this field and in many others involving automotive products.

The industry group that is here to make this presentation and to meet your Governor and other officials in the State, includes leading engineering and research executives of our industry and our top experts in this field that we are concerned with today. All five of the major automobile manufacturers are represented. If I may, I should like to take just a moment to introduce these men. First, the members of the Engineering Advisory Committee of the Automobile Manufacturers' Association: Mr. Charles A. Chayne, Vice President in Charge of the Engineering Staff, General Motors Corporation; Mr. Victor G. Raviolo, Special Assistant to the Vice President, Engineering and Research, Ford Motor Company; Mr. W. S. Berry, Director of Automotive Research, American Motors Corporation; Mr. E. J. Hartig, Chief Engineer, Studebaker-Packard Corporation. And now the members of the Vehicle Combustion Products Committee, the group that has been carrying out our cooperative work on vehicle exhaust problems: Mr. C. M. Heinen, Assistant Chief Engineer, Chemicals, Chrysler Corporation; Mr. C. E. Burke, Chief Development Engineer, American Motors Corporation; Mr. J. M. Campbell, Scientific Director, Technical Center, General Motors Corporation; Mr. J. M. Chandler, Supervisor, Test Engineering, Ford Motor Corporation; Mr. G. E. Onishi, Proving Grounds Test Engineer, Studebaker-Packard Corporation; and Mr. A. G. Culwell, Vice President, Research and Development, Thompson, Ramo-Wooldridge, Incorporated; and finally, Mr. Harry A. Williams, Managing Director, Automobile Manufacturers Association. Thank you, gentlemen.

For a number of years now we in the automotive industry have been seriously concerned with the problem of photochemical smog and air pollution. Our particular interests and efforts have been directed to researching, evaluating and developing methods for controlling automotive exhaust emission. Into this effort, during the past five years, we have put our best engineering talent and ability, devoted our laboratories to it, and developed test equipment especially for air pollution research. This entire program has had the encouragement, support and guidance of the top executives in our industry.

Today, you will hear the results of our intensive investigation. We are on the threshold of various approaches to the control and reduction of exhaust gas emissions. Considerable interest is expressed in methods and devices to control hydrocarbon emission. What are their prospects? Will we have one soon? Will it do the job?

Industry engineers here with me are prepared to answer these and other questions, as well as to point out the problems regarding the devices that we have tested. They will also point to other courses of action, maintenance of vehciles for example, that hold excellent promise for the reduction of tailpipe emissions. From an historical standpoint, the industry's interest in exhaust gases started with the earliest manufacturers of motor vehicles. Some of us may remember that the first automobiles emitted a great deal of visible smoke every time the engine fired. As refinements in designs were made, these smoke problems were eliminated.

In the mid-twenties there was concern regarding the concentration of carbon monoxide in the atmosphere of the more crowded cities. With improvements in engine combustion efficiencies, carbon monoxide emissions were drastically reduced. The result is that today with many more vehicles in use, carbon monoxide in the atmosphere is well below the level reported back in 1925.

A similar problem arose when tetraethyl lead was introduced as a gasoline additive to take care of engine-knock problems. The industry and the petroleum groups worked with the Surgeon General of the United States Public Health Service to establish safe levels of concentration of this additive in fuels. The industry did this to make certain that no public health problems would be created by the use of the new fuel additive. These actions help demonstrate the constant concern of the automobile manufacturers with any problems arising from the use of their products.

The unique characteristics of the California atmosphere came to our attention during the 1920's when we noticed that tires and other rubber products cracked and deteriorated in the Los Angeles area. Our engineers soon learned that, for some reason which no one was able to explain, the Los Angeles atmosphere had a higher concentration of ozone that was found elsewhere. We found that the ozone played a major role in the tire and rubber problem. The ozone test is now a standard one for rubber products of this sort. As a result of our interest in ozone effects, we have followed California atmospheric research efforts in this matter very closely ever since.

We have paid particular attention to the earliest reports of Dr. Haagen-Smit and his development of a theory which links some exhaust components with smog formation. The industry kept sending

engineers on technical missions to Los Angeles in 1950, 1951 and 1952 to become thoroughly familiar with the scientific knowledge that was being developed on smog formation. These engineers established close and frequent contacts and working relationships with the scientific and technical personnel and the city and county officials who were working on this problem.

As a reminder, I would like to point out that all that was known about smog in the beginning was the fact that it did occur in the Los Angeles area, and that a theory had been developed to explain the chemistry of the reaction in the atmosphere. In 1953, the Board of Directors of the Automobile Manufacturers' Association established an unusual cooperative research and development program to work on this problem. It was aimed at finding methods of dealing in a practical manner with air pollution to whatever extent the motor vehicle was a contributor. We were very aware of the fact that we were undertaking a basic kind of research program and hoped that by pooling all of our efforts and knowledge we could accelerate it. For this reason, the industry entered into a Cross-Licensing Agreement, which is a formal method of pooling our knowledge as fast as it is developed.

During the past few years, Los Angeles researchers, especially those associated with Air Pollution Control District of Los Angeles County, have provided us with a wealth of information dealing with local meteorology and with the emissions from various local sources. This information became invaluable to us in our work. I must mention, however, that the automobile industry has not always concurred with the quantity figures which state how much automobile exhausts contribute to the total problem. The reason for this is

that the exact measurement and the determination of pollutants in the atmosphere is still a somewhat unrefined art, and you will find a considerable variance in the published data pertaining to the subject; but the lack of confirmation of these statistics has in no way influenced the earnestness of our efforts, nor the scope of our program, nor the sincerity with which the research people in the industry have pursued their assignments.

As the development of control methods becomes closer to application, precise figures will become very essential. Speaking for the entire automobile industry, may I say again to you and to the people of California that the motor vehicle manufacturers are very serious about trying to solve the automotive part of the air pollution problem you have here in this State. Just as frankly, however, I must tell you that we are not in a position to determine the extent to which any remedies or devices made available by the automobile industry will actually eliminate or reduce the photochemical reaction in the atmosphere that is called smog.

There is probably no one with sufficient knowledge of these atmospheric reactions, either in your State and county official research organizations, or in any of the other smog research groups, who can give you any real assurance or positive guarantee that the elimination or reduction of automobile exhaust emissions is going to be a complete cure for the smog. Despite this absence of complete assurance, we certainly hope substantial reductions of hydrocarbon and nitrogen oxide emissions from automobile tailpipes will bring relief in the form of less intensity and frequency of smog.

My colleagues are prepared to provide you with information about the kind of research and testing programs we have been conducting, about what progress we have made to date, and about the potential methods we have found for reducing these emissions.

We will start with two members of the industry's Engineering Advisory Committee, Mr. C. A. Chayne and Mr. V. G. Raviolo. Then the members of our Vehicle Combustion Committee will make their presentation. I would like now to introduce to you a member of the Engineering Advisory Committee from the Ford Motor Company, Mr. Victor Raviolo. In his company capacity he is responsible for the direction of extensive engineering and research programs. Mr. Raviolo will discuss the factors related to the action program and some of the elements that must be known before remedies can be accepted and applied. Mr. Raviolo.

MR. VICTOR G. RAVIOLO: Mr. Chairman, distinguished Legislators and guests. The automotive industry has been concerned with more than the technical research program in the Los Angeles smog problem. There are six major aspects of the exhaust gas problem to be considered by the responsible authorities, and these aspects have also concerned us. These are fundamental points to be well considered before action of any sort is undertaken.

They are:

1. geographic distribution of the problem
2. possible effect of air pollution on health
3. identification of pollutants to be eliminated
4. economic impact on public and on control agencies
5. application of devices and/or procedures to old and new vehicles

6. legal problems of specification and control

Each of these points is important enough to warrant brief treatment in our report to you.

Geographic Distribution of the Problem

Los Angeles smog is distinctly different from notable air pollution in any other city in the world. The technical literature has precisely differentiated between the various kinds of serious air pollution episodes that have been recorded. The research people in Los Angeles have defined their unique problem as photochemical smog, a reaction of hydrocarbons with nitrogen oxides in sunlight. We accept their definition.

The automotive industry research team has devoted major studies to the factors which are the special characteristics of Los Angeles Smog. We are well acquainted with the problems of eye-smarting, extreme haze in the atmosphere, and plant damage, which are identified as primary results of the Los Angeles smog. The yard-stick applied in Los Angeles by the Air Pollution Control District to determine the seriousness of day-to-day smog is ozone or oxidant concentration in the atmosphere.

We have compared average measured values of oxidant in Los Angeles with those in a large number of other cities. The average is approximately one-quarter part per million in Los Angeles, which is about ten times as great as the average for a typical American city. In fact, the Los Angeles average is higher than the maximum concentration found almost anywhere else on earth. The few other cities where unusual concentrations occur and are measured, have about one-half the Los Angeles maximum. Later you will see these data

charted to help you gage the relative importance of this problem to various geographic areas.

As you consider the impact of this problem on the various communities in your state, we would like you to remember that the automobile industry wants to be helpful regardless of the measured oxidant values. On the basis of the available information, we feel bound to raise this question: "Do the circumstances justify an important expenditure by automobile owners throughout your entire state to deal with a problem that is so specifically pinpointed in one coastal area?"

Possible Effect of Pollution on Health

The automobile industry undertook its program of studying exhaust gas emissions on the assumption that there could be some health aspects involved.

Unhappily, there is not agreement on the health data among medical researchers. Publicly it seems, more has been deduced and implied about the health aspects than can be justified with any available scientific information.

We think it is our obligation to call attention without fear or prejudice to the facts, and we have joined with the Surgeon General of the United States Public Health Service to promote more intensive studies. This great agency can be accepted by all as competent, objective and impartial.

At this moment we make no case, pro or con. It is premature to form any serious conclusion from the available information, except to conclude that more information is needed.

Identification of Pollutants to be Eliminated

Two of the materials involved in the photochemical smog reaction are hydrocarbons and oxides of nitrogen. These come from many different sources. Later you will see some data as to sources, including motor vehicles.

Most of the public attention has been concentrated on the hydrocarbons. Indeed, our industry research has been directed largely toward the reduction of the emissions of hydrocarbons. There is a tendency to overlook the oxides of nitrogen, which, according to the Haagen-Smit theory, are an essential ingredient in the photochemical smog reaction. If that is true, and if it is necessary to control the oxides of nitrogen, then probably an additional requirement must be satisfied by the vehicle.

Industry researchers have discovered two methods for reducing emission of the oxides of nitrogen. They involve a change in the carburetor to enrich the mixture and a change in spark timing. We foresee a 25 per cent loss in miles per gallon to achieve maximum reduction of oxides of nitrogen. The cost to the average motorist is estimated at $40 to $70 per year (for 12,000 miles).

According to accepted theory, there must be a relatively fine balance between hydrocarbons and oxides of nitrogen to permit smog formation. Both of these constituents come from other sources besides automobiles.

We have already asked Los Angeles County officials for the percentage of exhaust clean-up required so we can perfect the most economic device. It will be a major responsibility for the Los Angeles County officials to decide just how much control of

each constituent is required, recognizing of course, that improper control may be useless, and that excessive control may be excessively costly as well.

Economic Impact on Public and on Control Agencies

These are the vital questions:

How much control is possible?

How much control is necessary?

How much will it cost?

We are here to give you all the information we have on the automotive aspects of the problem.

We have spent $5,000,000 in research on exhaust emissions. In addition, Ramo Wooldridge, Norris-Thermador and Clayton Manufacturing Co. (all of Los Angeles) are examples of other industrial researchers whose expenditures are proportionately heavy. All this has been done on the assumption that the control of emissions from automobile exhausts into the Los Angeles atmosphere would result in important mitigation of the smog situation. From all this, and from independent research, will come some method or device to reduce or change the emissions.

The final cost of such a device will depend on the final requirements, and the consequent degree of complexity or simplicity. The best estimates that we can make while devices are in the research state indicate that the devices to be described later might cost between $100 and $200. At an average of $150, and excluding special costs for installations on older vehicles, an outlay of more than $400,000,000 would be required to fit the device to the automobiles in one county, Los Angeles. Should the device be required through-

out the state of California, vehicle owners would be required to spend almost one billion dollars.

The magnitude of the inspection and control problem is almost staggering. Considerable time and thoughtful efforts will be needed by the control agencies to get such a program into existence and working effectively. After practical instruments are invented to replace the laboratory equipment now used, inspection stations will have to be set up and manned. Operating six days a week year around, and assuming an inspection every six months on each car, it will be necessary to inspect about 20,000 cars per day in Los Angeles County alone. For a quick inspection nearly 1,000 stations will be required if each is operated 16 hours per day. We do not have any estimate of the cost of these facilities, or of the continuing operating expense.

You will hear more later about smog-chamber studies, and about the great reductions in air pollution which are possible if engines are tuned up to give good performance and economy. This poses the obvious question - "What would be the result if all motor vehicles in the community were in good operating condition?"

Application of Devices and/or Procedures to Old and New Vehicles

The application of devices to new vehicles only would affect about 280,000 vehicles per year, at the present rate of sales in Los Angeles County. In six years - there would be control devices in 50% of the car population, in twelve years there would be devices in 85%.

The application of devices to existing vehicles raises some serious questions as to mechanical adaptability, the cost of individually engineering the great variety of system installations, in addition to the increased complexity of the inspection and control problems. The rate of population influx is no small aspect of the Los Angeles problem. In any event the application of devices would have some practical limit dependent on the current market value of each older vehicle, compared to the cost of the device and its installation.

The entire question of the rate of introduction and application of control devices or procedures, and the degree of effectiveness in reducing peak concentrations of pollutants in the Los Angeles atmosphere, obviously needs careful thought. Here again, the community officials and their technical advisers must make some determinations before official action is undertaken. Indeed, these determinations are also prerequisite to the final engineering of devices for production.

Legal Problems of Specification and Control

We have been advised from the time of our earliest association by officials of Los Angeles County and of the Air Pollution Control District, that they were (and are) legally empowered to take any required regulatory steps.

We have accepted this as a fact, and we assume it is still the legal foundation for the actions to be taken by Los Angeles County at the proper time. On this assumption, we have worked intensively with the County group and now have broken through on several important scientific fronts pointing toward control of the exhaust gas emissions.

Despite the costs and complexity of inspection, it would seem probable that there is a need for local officials to have some way of checking the effectiveness of any air pollution device or maintenance procedure. Periodic inspection will be required to determine whether the exhaust gas emissions are at some specified maximum.

The experience in other jurisdictions provides evidence that, where proper functioning of safety equipment is a question, such public inspection procedures are effective. This is the main consideration you might want to give to the regulatory problem so an effective inspection procedure will be in operation when subsequent control steps are started.

Conclusion

All of this information, we believe, is useful for you in consideration of the many ramifications of the exhaust gas control problem. We submit it as a factual background because we want to help Los Angeles deal with its air pollution problem. That is the only reason we undertook the imposing technical task of searching for some way to reduce exhaust emissions. Even though there seems to be no one who can determine exactly what the benefits will be of reducing the emissions, and knowing that no one can guarantee to eliminate smog, we believe we have found technically feasible methods to reduce undesirable exhaust gas emissions and now can develop them for practical application.

Another member of the industry's Engineering Advisory Committee, Mr. Charles A. Chayne, vice president in charge of the engineering staff of General Motors Corporation, will describe the industry

research program and its results, and the kind of action program which might be implemented in the communities where the problem is of such great importance. Thank you.

ASSEMBLYMAN REES: Do we have to wait until the end of the session, or can we ask questions as they go along after each person has given their presentation?

ASSEMBLYMAN RUMFORD: I propose, Mr. Rees, that questions be given at the end of the papers, that is, when the industry has completed their presentation.

ASSEMBLYMAN REES: We still have one, two, three, four, about five papers to go, and I'm just afraid that some of us cannot spend all afternoon here -- I have an appointment at 4:00 o'clock and another one at 4:15. Also we'll be giving questions that might be totally unrelated to the last material given, which will be, we'll say, the most familiar on our minds.

ASSEMBLYMAN RUMFORD: We'll try it, if you don't mind.

ASSEMBLYMAN REES: Yes, we'll try it, but I think that this thing should be cleared up right now, and that last paper, I think, contains some very glaring statements that just aren't true, and I just feel at the beginning of this session that we ought to try to clear some of them up. We have automobile exhaust problems all throughout the Pacific Coast -- it's not just in Los Angeles, and this is not a local problem.

ASSEMBLYMAN RUMFORD: Thank you very much, Mr. Rees. We'll see how it comes about, and if it is not agreeable, then we might have to change, but we'll try it anyway. Thank you. Proceed.

MR. CHARLES A. CHAYNE: Mr. Chairman, members of the California Legislature, and guests. The automotive industry's cooperative research on the air pollution problem was established on a very broad base. This was because no one could attempt to develop control devices without basic knowledge, and a means of measuring whether any device would do an effective job.

We were faced with many suggestions, all deserving evaluation. Some were easily appraised. Others required extensive investigation. Nothing conclusive could be learned without completing the time-consuming fundamental steps.

However, we believe we have made some tremendous strides. I will describe them briefly and then discuss specific approaches we believe might help in alleviating the air pollution situation.

Our cooperative program includes all vehicle manufacturers -- through the Automobile Manufacturers Association. Every company is represented in the main committee framework and on all task groups.

Men given task group assignments were told to work as closely as possible with California officials who had public responsibilities with this problem. They also have joined forces with every other research group working on similar problems. I would like to underline this.

We knew at the outset we were venturing along untrodden research and development paths. Substances we were seeking in the exhaust stream were present in quantities of only a few parts per million. This explains why we had to emphasize development of measuring instruments.

First success with such instrumentation was reported in May, 1955, at the Air Pollution Control Association meeting. More was reported in August, 1957, and January, 1958, before the Society of Automotive Engineers -- including work still continuing under our sponsorship and that of the Coordinating Research Council, being carried out by the U. S. Bureau of Mines.

Simultaneously we set out to measure typical Los Angeles traffic patterns and to analyze vehicles in use -- to find out how much emission occurred during various driving cycles such as idling, acceleration, cruising and deceleration.

You see, dependable data were unavailable. When we got it, one part of our program was set back. Original data of other investigators had suggested greatest amounts of unwanted emissions occurred during deceleration.

In an effort to speed progress, we developed devices to reduce hydrocarbon emissions during deceleration. But when these devices were perfected, data available by that time revealed that the deceleration emissions were less important than previously postulated. This greatly reduced the potential uses of our devices.

Even so, we showed them to the Los Angeles Air Pollution Control District in 1957. In short, we had some solutions to problems, but the problems seemed to change while we were working on them. This is the penalty of development work undertaken before basic facts are known.

These deceleration or induction system devices -- on the carburetor side of the engine -- were the first to be put into actual development.

But at the same time research efforts were increased for possible solutions to the exhaust side of the engine. Two of these were apparent.

One was some type of purifier to absorb or burn undesired pollutants. Chemists suggested catalytic treatment, but no satisfactory catalytic material was then available, suitable for this job.

The other approach was the direct-flame or non-catalytic principle, an afterburner built into the car exhaust system. It has been tried before, unsuccessfully, because most of the time so little unburned fuel was in the exhaust stream.

By mid-1957 the first scientific breakthroughs were scored with catalysts. Two companies achieved some success in the laboratories. This was reported in technical meetings and at the Southern California Conference on Elimination of Air Pollution at Los Angeles, November 20, 1957.

Early in 1958 we received word about successful test operations of a non-catalytic afterburner.

Testing of catalytic and afterburner methods was accelerated in 1958, beginning with elementary research stages and carrying through to a point where we have some research prototype systems fitted to automobiles. They show technical feasibility. Each of these devices is here today for your study and examination. You will hear more about them from our research engineers.

Now, although our enthusiasm is high, we don't want to arouse false hopes. The industry will not experiment on the public. Real problems remain to be solved. Some of these devices operate at such high temperatures that stainless steel components appear neces-

sary. Cost of catalytic materials and fabrication problems are important, too. The problem of additional air supply to complete the burning process, which may involve automatic controls, is likewise important. In addition are the problems of heat, odor and performance under maximum conditions that must still be studied. Not the least of our problems is that of noise.

While we work on these problems to refine designs and make them commercially acceptable, the cooperation of Los Angeles officials will be welcomed, as in the past.

One of these areas of cooperative interest with the Los Angeles Air Pollution Control District is its concern about fuels and their effects on the air pollution problem. We concur with them that the question of fuel volatility and effects of olefins should be clarified, and we will cooperate with them on this problem.

Meanwhile, along with our research on exhaust control devices, we have continued to study the vehicle itself. We have learned that the smog chamber work at Stanford Research Institute demonstrates quite conclusively that the eye-smarting characteristic of smog, so uncomfortable and troublesome, cannot be produced by exhaust pollutants from an automobile with the engine tuned to normal factory tolerances. We have also learned that the specialists concerned with the study of plant damage have difficulty in reproducing typical plant damage in this kind of smog chamber test.

It seems obvious that the operating condition of existing Los Angeles motor vehicles deserves consideration. Suggestions have been made that maintenance procedures can reduce a certain portion of objectionable exhaust emissions -- a portion resulting from poor mechani-

cal or electrical conditions in the engine. We reported in January what some of the prospects are for this approach to the exhaust problem.

Overall, this brings us to the point where we believe that reducing exhaust gas emissions can be approached hopefully and realistically through a step-by-step program.

A most likely first step would be vehicle inspection in the Los Angeles area to find out whether the vehicles are in proper mechanical maintenance condition. Inspection will be required to make any other solutions effective -- devices or maintenance.

Step Number Two, and probably concurrent with Number One, would emphasize maintenance -- this to make sure desired emission standards are being met and sustained.

We realize neither of these first two steps would be a quickie treatment. Educational and training programs are a requisite -- before the majority of Los Angeles motorists get their cars up to par, so to speak. Also, experience of communities that have public inspection procedures testifies that the inspectors must have technical knowhow and competence. And such programs involve considerable costs. But these steps are worthwhile and can be effective.

Indeed, it may take as long to implement inspection and maintenance procedures as it will take for our industry to refine and develop control devices to a point of commercial acceptability.

But the point, it seems to us, is this:

If proper inspection and maintenance doesn't reduce undesirable exhaust emissions to an acceptable minimum, then the Los Angeles County officials could use their existing authority for a

possible final step. This would be required use of some type of exhaust control device.

Meanwhile, the rest of California wouldn't have to experiment with unknowns. Should the time come when other communities, or the state as a whole, believe the air pollution problem requires additional control, the soundness of the steps would be proved beyond doubt.

Now, as concisely as possible, we will give you technical information on developments of our Vehicle Combustion Products Committee. It functions under our Engineering Advisory Committee, with full support of AMA's Board of Directors, which includes the chief executives of each motor car company.

Mr. Heinen, the committee chairman, will make the basic technical presentation. Other committee members who have researched the various devices will show them to you and explain their operation.

Later, we shall attempt to answer your questions.

ASSEMBLYMAN WILSON: I have the same request that Mr. Rees had, Mr. Rumford. We all have these papers --- mine is up in my office --- I can get it down here and read it if I want to -- but it seems to me that there are questions that should be answered as these gentlemen go along.

ASSEMBLYMAN RUMFORD: As I understand it, Mr. Wilson, some of these papers are supposed to answer some of these questions. By no means do we pretend to absorb and digest everything that is given and accept it as such, but we do want to allow these gentlemen the opportunity to present their case. Certainly we're going to have time to rebut and ask questions.

ASSEMBLYMAN WILSON: Are you doing a good whitewash job?

SENATOR RICHARDS: Mr.Chairman, in the interest of the latter comment, and because I think that in trying to be fair to these gentlemen, it should also be borne in mind that it not be simply a one-sided presentation because that would indeed be unfair due to reaction to the big questions later. Because the Senate goes into Session at 3:00 o'clock, and some of us are here from the Senate, and because this is technically a Committee of the Whole created by virtue of a Resolution concurrently passed by both Houses, I now move for a vote of the Legislators present that we do have questions put at this time, and that answers can be accepted. If the gentlemen want to tell us that this is answered in a subsequent document, if they will merely point out that fact, I for one would be glad to accept it, but in the event it is not, I for one would like to hear some answers, and I, therefore, move a vote that we allow questions as the organizational presentation proceeds.

ASSEMBLYMAN RUMFORD: I might say at the outset that, as I understand it, we could not, as a legislative body, pass a Resolution to appoint ourselves as a Committee of the Whole. However, I might appeal to the group at this point, and ask that we lend some few minutes for questions, if you will, Mr. Ackerman. I don't want to be rude, but the Senator does have to leave; if this is not agreeable, however, we'll continue. We don't want to appear that there's any whitewash job for, as the Senator said, that certainly would do more harm than good. At the same time we would like to see the papers presented. We know that the Senate is in Session at 3:00 o'clock, and under those circumstances, what is your desire?

MR. ACKERMAN: Naturally, gentlemen, when we came out here, we expected a great number of questions to be asked because we know this is of very great interest to all the people in California. In an effort to test ourselves we prepared a list of every question that we thought that could conceivably be asked which has a bearing on the problem and that would add to a clarification of the situation. We believe that the questions, insofar as the questions appear to have been raised, are answered in the subsequent papers. I really believe, to get the most out of this presentation, for the most people here, it would be to your advantage, and to ours, to hear the papers out; and I think, furthermore, that after hearing the rest of the material we have, the questioning could be more direct and, I think, contribute much more to the general information on the situation and what the industry is doing to correct it. I would be very much in favor of continuing with the papers if it were at all possible.

We tried to ask ourselves what we thought would be the toughest questions that you would ask here. Our people have been working with the people in Los Angeles, and they have been asked these questions probably many times before, so we have prepared this material. We believe that it answers the majority of the questions. I couldn't assure you that you wouldn't ask a question that we do not have a prepared answer for. But we do believe the whole thing will be more beneficial to all concerned if you would be kind enough to hear us out. Of course, if it's impossible, we will go along with you on the questions. I would highly recommend hearing the papers out.

ASSEMBLYMAN RUMFORD: Could I then prevail upon you to hear Mr. Heinen's paper now. As I said, we are willing to go along with the consensus, you have heard Mr. Ackerman's statement -- do you still feel the same way?

(It was decided that questions would be addressed to the speakers at this time.)

SENATOR RICHARDS: I would like to ask Mr. Raviolo just two or three questions, if I might, to straighten out some of the problems raised by his paper.

ASSEMBLYMAN RUMFORD: Mr. Raviolo.

SENATOR RICHARDS: Mr. Raviolo, I believe you have stated that it is accepted that the photochemical smog is caused by hydrocarbons and by nitrogen oxides. With that in mind, my first question is: Do not, to your knowledge, the automobile exhausts and the automobile itself contribute, item one, hydrocarbon?

MR. RAVIOLO: Yes, they do.

SENATOR RICHARDS: Item two, nitrogen oxide?

MR. RAVIOLO: That is right.

SENATOR RICHARDS: And is it not also true, so that there be no confusion in regard to the Los Angeles statistics, that whereas the problem is indeed greater in Los Angeles, there is also a greater concentration of automobiles in Los Angeles, both per square mile and per capita than anywhere else, either in California, or in the Nation, or in the World?

MR. RAVIOLO: I can't answer the question on the concentration -- I don't have the figures right now.

SENATOR RICHARDS: If it were true, and this is my last question, just to clarify these inferences which we are going to have to answer as bills come before the Legislature. If that is true, and if both of the factors in photochemical smog are contributed by automobile exhaust, would it not be logical to assume that the same problem would exist in any area granted the same temperature inversion and the same concentration of automobiles?

MR. RAVIOLO: That, I think, is a perfectly logical sequence, granted the same temperature inversion, granted the same climatilogical and geographical conditions, and the same concentration of automobiles, I think it is reasonable to accept the same results from pollution of the atmosphere.

SENATOR RICHARDS: And then, one more question if I may. Is it not also true that the same temperature inversion, or roughly the same temperature inversion system exists, insofar as your investigation is concerned, within the State of California for over one hundred days per year in the Bay Area and in the entire lower San Joaquin Valley and, for that matter, for a good portion of the year right here in Sacramento, the great difference being a lack of concentration in those areas, barring the Bay Area, of both industry and automobiles, to the same degree that you find it in Los Angeles?

MR. RAVIOLO: Well, first, Senator, I'd like to reply that I'm a long ways from being a weather expert, and so I am not going to attempt to answer on the climatilogical conditions in the various areas. Let me say this, that the specific measured peak concentration in all of the various cities that are of prime interest are

covered in the very first lines of Mr. Heinen's presentation. I don't want to refer to these directly because it would be redundant -- you will see them, and further, you have the information in the material which was prepared as a whole. Let me just point out one factor --- that the lowest figure that we're talking about in Los Angeles, the lowest estimate that has been put forward, and that is shown on Mr. Heinen's slide, is a figure of "1", and the same relative measurement of peak concentrations shown for the Bay Area is .6. From there, when you go into the other coastal cities, you rapidly get down to the levels which, according to the Los Angeles authorities, are below the level of eye irritation. Now, as I say, Mr. Heinen covers these in great detail, and I don't want to be too redundant, so I'm going to leave the major part of the answers to him. The theory of photochemical smog is not an automotive industry theory. This was developed by scientists in the Los Angeles Area; as I indicated, we have accepted this as a working basis, and have based our work on it, but it is not our theory, nor are we putting it forward.

ASSEMBLYMAN RUMFORD: Shall we proceed with Mr. Heinen at this point, or are there further questions? Go ahead, Mr. Heinen. I think it has some bearing on the Senator's question.

MR. CHARLES M. HEINEN: All right, gentlemen. Mr. Chairman, ladies and gentlemen, this overall technical presentation by our group will be mostly visual, using slides and a display of the devices themselves. The first three slides, which are of particular interest at the moment, will outline the broad problem. The next four slides will relate the problem more clearly to the local urban situation. The remainder of the slides will deal with the proposed solutions and their

applications. So, with that background, may we have the lights and the slides, please.

Slide I shows that smogs are different. Scientists have compared the Los Angeles smog with the London smog, these are meteorlogical scientists --, and generally, that is what is summarized there. Each characteristic, as you can see, is different: temperature, humidity and wind -- each characteristic except wind. Type of inversion is different, the probable occurrence is different, the principal components are different, the effects on human beings are distinctly different. As for oxidation and reduction toward chemicals, in chemistry these are just as different as "male" and "female" in biology. Oxidation is the predominant evidence of the Los Angeles type smog. Oxidation is the yardstick which is used to identify and measure the Los Angeles type smog.

Now, Slide II shows how high the oxidant value in Los Angeles will be found on an average day and on a peak day. This slide compares it with five other cities in the United States. The San Francisco oxidant problem appears much less than that for Los Angeles as you can see, but the importance of some of the other characteristics of the Bay Area pollution problem is such that we intend to discuss it further in connection with remedial steps. The three cities, Santa Clara, San Diego and College, Alaska, occasionally have occident values that approach the generally accepted eye irritation level of .25 parts per million. These six cities were the only ones in the United States in which the oxidant is reported to be over a tenth of a part per million. Oxidant is not, according to the reports, a problem in Cincinnati, Detroit, Philadelphia, St. Louis, New York, or Washington, among others --- there are about twelve or thirteen others listed in the literature.

Slide III is the word description of the famous Haagen-Smit photochemical theory, a very simplified description, I might add. It says that oxides of nitrogen and organic materials which include olefins and hydrocarbons react in strong sunlight, and this is important, to produce ozone oxidents and other smog irritants. In this reaction it is known that certain ratios of oxides of nitrogen and organic materials are needed in the sunlight to produce smog. This means that the degree to which oxidents can become a problem in the atmosphere depends on the amount of oxides of nitrogen and of organics present. From this fact comes the conclusion that if the sources of these materials are found, and if they are reduced or eliminated, then the oxident reaction could be decreased and the Los Angeles problem could be reduced.

Now, since motor vehicles are among the various sources of invisible organics and nitrogen oxides, the industry is working strenuously to decrease the automotive-caused emissions in the areas where the meteorology is such that the emissions react to cause an oxident problem, a particular type of smog, oxident smog.

Slide IV shows the reports of the Los Angeles Air Pollution Control District, the latest reports, on organics, or call them hydrocarbons if you wish, in the atmosphere, I believe the report was quite recent --- October. The estimated total is about 1850 tons per day, when you add that little question mark in there, from motor vehicles, about 1200 tons per day, and from exhaust alone about 1000 tons per day. The figures for evaporation from gasoline tanks and carburetors are strongly dependent on the temperature; mostly it occurs on hot days, and in view of this uncertainty and in view of the fact that the 200-ton figure is ours, extrapolated from A.P.C.D. data, we have put

the question mark in there. All the other figures on this chart are the latest published data of the Los Angeles Air Pollution Control District.

The assumption, then, is that motor vehicles contribute 55% of the total or up to 66% on hot days when evaporation is important. This is the hydrocarbon situation that the automobile industry has been working on.

Slide V shows similar Los Angeles Air Pollution Control District reports on nitrogen oxide emission. These reports indicate that the motor vehicle is the source of 62% of the oxides of nitrogen; 265 tons are contributed by other sources.

Slide VI shows the Bay Area estimate, again their Air Pollution Control District, of hydrocarbon materials, and it is compared in the top two bars with the Los Angeles figures. The orange bar takes into account evaporation estimates as it did in the previous bar. Despite population and area differences, the San Francisco community reports over 750 tons more than Los Angeles, not including evaporation. You will note that we listed the evaporation as only 100 tons because of the smaller number of motor vehicles, and the slightly cooler temperature. The total vehicle contribution of 700 tons is only 28% of the total organics in the Bay Area atmosphere, as compared with 66% in Los Angeles, which I mentioned earlier. Agricultural burning and incinerators play a large role in the Bay Area organics content, while these two sources have been virtually eliminated in Los Angeles. This suggests the need for a different remedy in San Francisco than in Los Angeles. The report of the National Air Pollution Conference has emphasized this need to apply proper remedies in each locality.

Slide VII. In comparing the oxides of nitrogen between the two communities, the figures indicate that the vehicle is the source of 51% in the Bay Area, but 62% in Los Angeles. Other sources also show different contributions in the comparison between the two areas.

Now, recapitulating what has been shown by the last seven slides, the situation is this: There are many different types of air pollution problems, and each community must be evaluated separately. The problem in London cannot in any way be compared with that in California because only the Los Angeles type of smog is identified by oxidation. The two California cities which seem to have an oxidation smog problem from air pollution are Los Angeles and San Francisco, but the two seem to be identified by their Air Pollution Control Districts to be attributable to different specific sources in varying degrees. The motor vehicle is much more clearly singled out by the Los Angeles data, but the other sources are shown as much more important in the Bay Area. At the levels indicated, in San Francisco the motor vehicle could not be classed as the major contributor. This is the background information which formed the basis for our industry program. Against this background we have conducted our search for methods to be applied where needed to decrease the vehicle contribution of oxides of nitrogen and organics.

Slide VIII: Poor car maintenance causes major increases in the amounts of hydrocarbons submitted to tailpipes as unburned fuel. To achieve efficient fuel combustion, and thereby minimize hydrocarbon exhaust, involves routine maintenance to insure that all electrical parts, such as points, spark plugs, condensers and wires are in good operating condition. Also, that carburetors be clean and adjusted for

new 1958 car condition. This appears to be an excellent approach to us for decreasing hydrocarbons, and we feel that it merits a real serious consideration on the part of the interested groups. The hydrocarbons resulting from evaporation, however, still remain at the 200-ton figure, and this amount cannot be reduced by maintenance. Incidentally, the evaporation cannot be reduced by devices -- you might remember that when we talk about devices in just a moment.

Two approaches have been suggested to try to control the evaporation problem. The first is to seal the fuel system by changing gasoline tanks to withstand crushing pressures, and by putting pressure caps on gasoline tanks. Then for us to artificially cool the carburetor to allow internal venting. Changes of this magnitude would cost several hundred dollars per car. It probably would not be too practical on any but new vehicles, and might be aiming a big cure at a small part of the total problem.

The second suggestion is to reduce the volatility of the gasoline so that it will not evaporate so fast. Since vehicles will operate on gasoline of considerably lower volatility levels than is common today, this approach is feasible from the viewpoint of all vehicle owners. Thus this chart shows that maintenance and fuel volatility methods for decreasing hydrocarbons are worthy of consideration, I believe, in the City of Los Angeles.

Now, Slide X completes the second of these three series -- this completes the picture on maintenance and fuel volatility by showing how these might apply to the Bay Area. Actually, this shows that in the Bay Area automotive emissions, which are now at a proportionately

low level, might be economically reduced to a completely satisfactory level through a soundly administered maintenance program.

Slide XI is a simple presentation of the complex arithmetic that develops when each year's new car sales total is added to California registrations and a somewhat smaller number of old cars is scrapped or not registered. The history of registrations for the past twelve years, which is shown here, shows that if some new piece of equipment had been installed by the manufacturers on all new vehicles beginning in 1946, only 50% of the total registration would have had this equipment by 1952, and only 85% of the cars on the road today would have it. Extrapolating this historical trend, it would appear that if a piece of equipment were specified for installation on all new cars to be sold in California today, it would take six years before 50% of the cars on the road had it and twelve years for 85% of the population of California to be so equipped. This suggests the following conclusions to this portion:

First, any remedies that can be applied to all existing vehicles and all new ones deserve first consideration. Maintenance, regular inspection and control of fuel evaporation characteristics are obviously in this group.

Second conclusion, the industry and the State or communities must carefully decide on the best course of action in considering new devices whose cost or complexity of installation is questionable on older vehicles.

Third, installation on existing vehicles may need a separate type of approach if it is decided that the program for installing devices on new cars only, following this curve up here, would not accom-

plish the desired results fast enough.

Slide XII. This shows the results that can be anticipated if devices are applied along with steps to keep vehicles in good operating condition. The starting point here is to reduce the burden of work for the devices by eliminating as much of the emissions as possible by maintenance. I do want you to understand that in considering each of these ideas you should remember that the devices can be made to work even if the maintenance conditions are not ideal, but their work is less if the emission level is less, and, incidentally, fuel is saved. After all, these devices are mostly rather complicated furnaces that burn the small quantities of fuel not used in the engine. The larger the charge to be burned, the larger the furnace must be, and the more often it must be replaced; therefore, we are assuming, for the purposes of this chart, that we start with well-maintained cars. Size and frequency of replacement, of course, both increase the cost.

To begin with, we estimate that proper maintenance alone, as is shown by that cross bar, could reduce the present estimated 1027 tons of exhaust emissions to 323 tons per day in Los Angeles. Additional reductions believed possible with various technically feasible devices, which will be described shortly, are as follows:

First, the vacuum-limitor or comparable induction system devices could bring the emissions down to 256 tons per day from 323. Secondly, the low temperature catalyst could reduce the total to 81 tons, as could the single-unit high temperature catalyst, which will be described. The dual-unit high temperature catalyst, plus rich carburetor mixture, could reduce the total to 25 tons, and the non-catalytic after-burner could reduce the total to 20 tons, according to the studies we have made so far.

Now, it can be seen maintenance practice and various types of devices could be specified which could reduce hydrocarbon emissions to levels as low as 2% of the current Los Angeles Air Pollution Control District figures for motor vehicle exhaust contribution.

In general, the higher the degree of elimination, the higher the cost. Considering all sources, what is the minimum hydrocarbon elimination that has to be achieved, and at what price? We hope to get an even clearer idea of the target from the Air Pollution Control District staff and others in Los Angeles when we go down there later in the week. But this is the kind of question that must be answered when you get to the practical stage.

Slide XIII again emphasizes that each community has a different problem. Here is a comparable picture for San Francisco. An evaluation here might lead to different conclusions since they can achieve a high degree of control without expensive devices. They could be at the 5% level, for instance, with the comparatively simple and inexpensive vacuum limitor.

Slide XIV shows what could be done to decrease emissions of oxides of nitrogen in Los Angeles. The motor vehicle exhaust contribution might be cut down from the estimated 430 tons daily to 39 tons by the enriched carburetor method, which uses up to 25% more gasoline. A system using both the rich carburetor to reduce the oxides of nitrogen and a catalyst to reduce hydrocarbons, if this combination is desired, has been tried and will be described later.

Slide XV, and the final slide, shows the Bay Area situation with respect to oxides of nitrogen. As is shown here, using the same methods as above, the total might be reduced to 20 tons from 237.

Now, it becomes apparent, I think, from the research that various devices and procedures will produce varied results. My associates, who have devoted themselves for five years to this program, will discuss the devices we have tested and found feasible. They will advise that any device, or any procedure, must be accompanied with some sort of regular inspection system. For instance, the catalytic after-burners require regular replacement of the catalyst if they are to be effective. The noncatalytic after-burner will have controls which have to be kept in good condition, and it will undoubtedly incorporate some ignition source which must be inspected periodically. The need for inspection in connection with maintenance, I think, is obvious.

Now, as you look at these devices, which will be described, I wish you would bear two points particularly in mind because they have an important effect, I believe, on your thinking. First of all, the degree of maintenance that is required for each of the devices; and secondly, as I pointed out before this is quite important, the possible complications in applying these devices to either new or to used cars.

Now, it gives me real pleasure to introduce Mr. Carl Burke, a member of our Committee, who will discuss the induction-system devices for you.

ASSEMBLYMAN RUMFORD: Mr. Heinen, just one second there --- Mr. Wilson, do you have a question?

ASSEMBLYMAN WILSON: Do I gather from your talk that if we had nothing but new cars, why we'd probably eliminate a great part of this problem?

MR. HEINEN: I did not say that, sir. As a matter of fact, if you'll check my latest paper, you will find that new cars can get out of adjustment. It just happens that this particular fleet was in good adjustment, and I was using it for comparison. Cars in good adjustment, yes, you could eliminate a major part of your problem. I am not here selling cars today for a change.

ASSEMBLYMAN WILSON: It sounded like it.

ASSEMBLYMAN RUMFORD: Do you have a question for Mr. Heinen, Mr. Bane?

ASSEMBLYMAN BANE: Yes, I'd like to ask -- you talk about proper maintenance. This means the motor tune-up -- how often would this be, every thousand miles, two thousand, ten thousand, what do you have in mind as far as proper maintenance is concerned?

MR. HEINEN: Actually, we have not established the exact figure. You saw what could be done with the rough five thousand mile maintenance figure. What we're saying here, and what we hope to discuss with the Los Angeles Air Pollution Control District is what type of a program might be set up. It depends a lot on the -- we think possibly on the type of driving and so on. So, we have to get the exact figure up there. But we're thinking, frankly, of five thousand, or something in that area.

ASSEMBLYMAN BANE: Then, to continue that same point, how major an adjustment is it, how major a maintenance job is it, and what would be the approximate cost of this type of maintenance for every five thousand miles?

MR. HEINEN: Well, reading from the paper here, you may have noted I covered plugs and points and the ignition system generally, plus adjustment of the carburetor -- I don't know what your going rates are here, but you've had that job done for yourself, I am sure, at the service station, and you can answer that for yourself better than I could.

ASSEMBLYMAN RUMFORD: Mr. Conrad.

ASSEMBLYMAN CONRAD: Mr. Heinen, this question is absolutely sincere and I'm not trying to be facetious either, but I know what I am going to hear when I go home tonight because I have heard it many, many times from my mother, from my sister and from my wife; every time I talk smog to them, they invariably say the same thing -- that eye irritation in Los Angeles County came to them in 1943 when my wife and my sister were working in a defense plant and my brother and I were overseas. There was an absolute minimum of automobile use at that particular time, and there was rationing. Every time I talk smog, they say "Now, don't talk about all these automobiles coming in Los Angeles County because when we felt it was in 1943 when the automobile travel was at a minimum." Now, is it the new type of engine that has come in since one war? Is it a new type of gasoline? Or why is it that this started in 1943 when automobile travel was at a minimum?

MR. HEINEN: This comes back to a question of sources. Actually, there is no specific information on the various sources and the tonnages at that time, but if you have been following Smith Griswald's report, you will notice that they change regularly. This is because there is a change in the sources. For instance, the petroleum industry has done a rather substantial job in reducing the evaporation losses

from petroleum. Without data for 1943, I can't tell you what it would have been at that time, but undoubtedly the total organics at that time shaped up fairly close to the total organics now. They came from different sources. You saw that in the San Francisco area, for instance, the total organics came from widely different sources than they did in Los Angeles. I presume that in 1943 the total count might have been the same, but the sources could very conceivably have been widely different, and I think that comes as close to answering your question as I can.

ASSEMBLYMAN RUMFORD: Mr. Chapel.

ASSEMBLYMAN CHAPEL: To follow up the -- do not run away, sir, if you don't mind -- you don't have to answer this -- to follow up what Charles Conrad said, only to be more specific, we eliminated, you know, the backyard incinerators -- you remember that -- that was supposed to be the great cure-all, you remember that -- do you remember that, sir?

MR. HEINEN: Yes, indeed.

ASSEMBLYMAN CHAPEL: And it was not the great cure-all. Now, I have no brief for the automotive industry or the producers of petroleum products for the automobile industry, but how do we know that after we go after this, that this isn't just another whipping boy, and after we attempt to solve, or partly solve this problem, which I am certain cannot be completely solved, any more than any other problem can be solved by legislation, how do we know that you won't come up with still another whipping boy. In other words, there has to be a point of no return. Do you think this is it, or do you think that this is still a cover-up for industry and for the petroleum industry in general -- in other words, is this another dodge -- that's what Conrad really was asking you, only in more polite language. How can we know that we come to a point of rest

on this, or how do we know that this just ins't like the incinerator thing? This is asked without malice, without instigation, an honest question -- how do we know, because after we lick one straw man, then another straw man is arranged -- and now we ask for the answer. As the Honorable Charles Wilson said, "let them answer". This is a great question, sir. Thank you.

MR. ACKERMAN: You have asked a sincere question, an honest question, and I certainly would like to give you an honest answer. The automobile industry is not trying to sell high temperature or low temperature catalytic mufflers, nor after-burners. We have no assurance whatever that reducing the unburned hydrocarbons from gasoline exhaust will eliminate or materially alleviate the smog situation in Los Angeles, or any place else. Our objective here is to eliminate those factors which are now indicated as contributing to the smog problem, but we certainly could not give you an honest answer and say we can assure you to any extent whatever that this would materially alleviate the problem. We are doing our job as best we know how to do it, working with the people in Los Angeles, and we feel that this is a problem, and if it's a problem and we can eliminate it, you can be sure that we are going to give our best efforts to it.

ASSEMBLYMAN RUMFORD: Mr. Wilson has a question.

ASSEMBLYMAN WILSON: Mr. Ackerman, is there going to be a paper on the effect of the gasoline or petroleum used -- will that come into the ---

MR. ACKERMAN: Yes, it will -- not in great detail, but it will be ---

ASSEMBLYMAN WILSON: The reason I asked is that I think Mr. Lanterman and Mr. Backstrand and myself sat on a subcommittee a couple of years ago where it was alleged by one witness that there is a difference in the type of gas in the Eastern States where you have extreme temperatures of both the heat or cold, and that in California, because of the normal temperature we have throughout the year, that there is a lower grade gas that is produced here and is used in the vehicles. I was wondering if that could have an effect on the -------

MR. ACKERMAN: Well, as Mr. Heinen treated it, volatility is a factor, and he would say here that in this area of the country the higher volatile fuels are not as essential as they are in the East, and if the volatility were lower, that part of the contribution might well be eliminated.

ASSEMBLYMAN RUMFORD: Mr. Rees.

ASSEMBLYMAN REES: Sir, on your assumption that the air pollution problem is different in San Francisco than it is in Los Angeles, wouldn't you say that the problem is basically the same because Los Angeles has had a district that has been working now for nearly ten years, and it has a program that is an advanced program, and the Bay Area really, which just created its air-pollution control district, is just starting their industrial and incineration program, and that once the Bay Area program gets to the level of the Los Angeles program, you will find that a major part of the air pollution problem in the Bay Area will be exactly as it is in Los Angeles and that it would be again due to automobile exhaust?

ASSEMBLYMAN ACKERMAN: As long as you use the word air-pollution problem, I have no argument with you. However, I think that Mr.

Heinen indicated that as the industrial situation is cleaned up in Los Angeles, the usage of automobiles increased, and the two counterbalance each other so that the atmospheric count probably was about the same, accounting for the condition in '43 and in '58 that was indicated. I think that in the Bay Area a clean-up of the industrial air pollution might be counteracted by the increased use of automobiles, but I think you will find that it won't be possible to crowd as many automobiles in the Bay Area as is possible in Los Angeles, It is a relatively small area, and it's just possible that the automobiles would not contribute as much to the air pollution, even after the industrial pollution was cleaned up, as is the case in Los Angeles. We don't anticipate a similar problem in the Bay Area that we are encountering right now in Los Angeles.

ASSEMBLYMAN RUMFORD: Mr. Lanterman.

ASSEMBLYMAN LANTERMAN: I'd like to ask this question of Mr. Heinen, and I think I did unofficially this noon, but I think we should bring it out, that no amount, in your opinion, Mr. Heinen, no amount of inspection of automobile maintenance would cure the driving habits of the unthinking motorist who keeps pumping his accelerator in traffic conditions, and thereby injecting through his accelerator pump, raw gas into his motor, which cannot be combusted entirely due to the low speed operation of his motor. Is that a factor?

MR. HEINEN: Well, I'm not an experimental psychologist, I presume that it is so, yes.

ASSEMBLYMAN LANTERMAN: But there is considerable injection of raw gas through the accelerator pump manipulation by people accelerating their car or gunning their motors.

MR. HEINEN: Yes, that occurs both in acceleration and deceleration, which is the result of ----

ASSEMBLYMAN LANTERMAN: Well, in any event, do we have to have these accelerator pumps as exaggerated in their effect as we now have them on the cars, do we have to have that ---- for a performance that is normal in operation, other than for spectacular getaway?

MR. HEINEN: Well, this gets into rather complex discussion of the exact performance level that you're shooting for --- I'd be very happy to stand here for five minutes and try to answer it -- but depending on what you want in the way of performance level, you build your pump that way, and ----

ASSEMBLYMAN LANTERMAN: Spin-rubber get-away, you have to have an accelerator pump for that purpose, but the point is do you need it for normal acceleration?

MR. RAVIOLO: Yes, yes, you do -- it depends just on the degree that you're talking about here, sir -- could I talk to you about this one later because it is one of these things that I've talked with --

ASSEMBLYMAN LANTERMAN: We have raised the question anyway, as far as inspection is concerned, and no amount of inspection will cure that problem.

MR. RAVIOLO: I think, just for the record, the acceleration of the vehicle is not dependent on the accelerator pump as such. That covers up cold in the carburetor, and without the pump to give you good carburetor performance, you would have a car that you wouldn't like to drive. Now, we do try to educate our drivers and the people to use the accelerators efficiently because if they don't, it results in high fuel usage, and we get fuel economy complaints. So it's to our advantage to try to encourage the kind of driving that you feel would tend to reduce your problem.

ASSEMBLYMAN RUMFORD: Mr. Elliott.

ASSEMBLYMAN ELLIOTT: Mr. Heinen, if he would comment on the relationship of the amount of horsepower and the amount of gas consumption to the amount of smog that is emitted from motors -----

MR. HEINEN: I suppose this is the small car vs. large car question ---

ASSEMBLYMAN ELLIOTT: Well, the horsepower would, of course, relate to size of car, but for the number of horsepower, the amount of horsepower, and also for the total amount of gas consumption -----

MR. ACKERMAN: Inasmuch as Mr. Heinen is basically a chemist, I think that this is out of his category. Horsepower as such makes no material contribution to the pollution problem. If you have to move a vehicle of a given weight and you want to move it at a given rate, you can do it with more horsepower, but if you were to move that vehicle with, say, with a smaller displacement engine, and wanted to move it at the same rate, which means more ratio, your displacement per ton mile would probably be about the same, and I would say your pollution would be about the same. Does that answer your question?

ASSEMBLYMAN RUMFORD: Mr. Gaffney, do you have a question?

ASSEMBLYMAN GAFFNEY: I have a question that I would like to quote, uh, a simple statement from Dr. Haagen-Smit, who conducted the research in the Los Angeles area. He says that Los Angeles is not unique in the smog problem -- it merely happens to be leading the parade. Smog is an inevitable result of increasing use of petroleum products in refineries, in industrial plants, and in automobiles. You will find it in London, Paris, Philadelphia, San Diego, San Francisco, and many other cities, as well as in Los Angeles. It's not a winter smog that

comes from soot. It can, and does, happen any time of the year whenever the use of petroleum products exceeds a certain level. My question is, and it's based on listening to the first gentleman who spoke from that platform, giving us an idea that the automotive industry had practically reached a stone wall -- that it all depends on future research and so on. Now, we are a little bit conversant with the problem. We know that the automobile is not the sole contributor. We know there are other sources, but -- isn't it fair to ask you that the automobile industry accelerate its effort toward the solution of its part of the problem, contributing to that problem, and not a sort of narrow cue that we've done as much as we can to this point, and then talk about devices that are going to cost motorists millions and four hundred millions of dollars in Los Angeles County, and you move it up to State use of automobile owners, --- a billion dollars and all that sort of thing --- I don't like that kind of approach to the problem --- wouldn't we be better to go away from this chamber feeling that the automobile industry is going to accelerate its efforts and try to cure what has been brought out scientifically, I have heard several times no scientific pronouncements. There is all kinds of scientific pronouncements that the exhaust from the automobile is a contributor to smog, and we know the exhaust from chimney smoke in industry is a contributor --- we know that the incinerators in everybody's backyard in Los Angeles was a little part of the contributing force, and they have been eliminated. Could I ask you, in all humility, that the automotive industry will simply step-up its efforts to do its part in solving a problem that is becoming a problem in every metropolitan area, not only Los Angeles ---

MR. ACKERMAN: If you men leave this chamber today with the impression that the automobile industry is not stepping up to its responsibility in this problem, we will have failed. I have said before, and I say now, that we have accepted this challenge -- we have not stated to what extent automobile exhaust gas emission contributes to the formation of smog. We have said that we will accept the responsibility of creating devices that reduce the emissions that are known to be factors in smog, and we will prove to you, I believe, if you will remain with us, that we have made a major break-through. We do have devices now that are effective; we have devices now that we believe are approaching a practical form if they can be used and installed on vehicles, and will do the job of reducing materially to the extent of possibly 90% of the emission of unburned hydrocarbon. We are not going to stop until we have a device that we can submit to the air-pollution control people in Los Angeles, and they will say, "Gentlemen, this does the job that we've asked for.", and we would say, "Gentlemen, this is a satisfactory unit, and it's ready for use on vehicles to whatever extent you wish to use them."

ASSEMBLYMAN GAFFNEY: Pardon me, Mr. Chairman, only this point -- could there be further research on the fuel itself, but not so much on a device, or the acceleration, or carburetor adjustments, or devices placed in the present engines. Could there possibly be research along the lines of the fuel itself, what constituent part it plays, and possibly a different kind of a fuel?

MR. ACKERMAN: There will probably never be a time for research in any area of this kind that won't bring results. We feel that we have a basic problem. The type of fuels that we are using now results in these unburned hydrocarbons --- at the moment the industry is not smart

enough to build an engine that doesn't emit some unburned hydrocarbon that we have devices to control. At the moment the fuel situation, I think, is covered in major part by eliminating the evaporation of fuel and gasoline. I wonder, if you gentlemen will permit, we would like to have a change of subjects.

The next subject we would like to discuss with you is the devices that were developed to reduce hydrocarbon emissions during acceleration. This was the 'white hope' sometime ago --- we felt that there was a great deal to be accomplished in this area, and it was subsequently proved not to be the case, but Mr. Carl Burke, Chief Development Engineer of the American Motors Corporation, will give you this part of our story. Mr. Burke.

MR. CARL BURKE: Gentlemen, my report will deal with a family of devices which were designed to be applied to the carburetor and intake manifold of engines to reduce, or cut off the fuel flow of gasoline during deceleration. Realizing the urgency of the Los Angeles problem, we operated on the basis of a crash program. We by-passed our usual research procedures, which seek out a clear and accurate definition of the problem before the cure or fix is approached. We started our device-developement program with a minimum of data on the exact amount of the automobile's contribution to the Los Angeles problem, but with the assumption that an important percentage of the hydrocarbon emissions did occur during deceleration. An overall study of the problem indicated that two basic approaches to the question of the induction system devices were:

1. To improve the engine efficiency during deceleration by reducing the normally high manifold vacuum during this cycle by a special throttle control; and

2. To cut off the flow of fuel when the vehicle is slowing down or decelerating.

We tried both general methods and developed devices in each classification that would do an effective job in controlling emissions during deceleration. The purpose of the vacuum-limitor type of throttle control is to keep the intake manifold vacuum below the value of twenty-one to twenty-two inches of mercury, at which engine combustion is most efficient. Normally, during deceleration the manifold vacuum goes higher, and the engine operating condition becomes less efficient, so there is an increase in hydrocarbon emission. A straightforward way of reducing manifold vacuum during deceleration is to prevent complete closing of the throttle during deceleration. Two different types of throttle controls were developed and tested. One of these is called the slow throttle return dashpot. It slows down the throttle action during the last few degrees of movement of the throttle into the idle position. Our first slide shows a cut-away view of the slow throttle return dashpot.

The second type of throttle control is called a vacuum control throttle opener. This device automatically opens the throttle when necessary and desirable to reduce and regulate manifold vacuum to a predetermined value to help decrease hydrocarbon emissions. This type of throttle opener is shown on our second slide.

In general, installation problems with these devices were not difficult. The major objection to this kind of device is that it reduces engine-breaking normally obtained because of engine compression. Therefore, it requires an increase in the use of brakes in normal driving and results in an increase of brake wear.

The second approach resulted in the development of a series of various designs of idle fuel shut-off devices. A wide range of concepts was developed and tested. The purpose of these fuel shut-off devices is to stop the flow of gasoline through the carburetor idle system during deceleration and idling. This was considered a promising means for substantially reducing hydrocarbon emissions. One of these idle-fuel shut-off devices is shown in a schematic diagram on our next slide. Normal idle fuel flow is occurring in this slide.

Our next slide shows the device operating and the idle fuel flow cut off. This shows that in operation of the device, air is admitted into the idle system of the carburetor while the high vacuum deceleration condition exists. This cancels the suction which normally causes fuel to flow through the system.

Slide V is a photograph showing a carburetor equipped with an air-bleed type idle-fuel shut-off. The fuel cut-off devices were found to affect the driveability of cars adversely by introducing stalling in some cases and flat spots, or surging, in others. Also, it would be difficult to adapt this kind of device to the many different carburetor designs now in use.

Our final slide shows a summary of results in reduction of hydrocarbon emission during the deceleration cycle, using the devices discussed. Included are various types of deceleration conditions.

The reduction in hydrocarbon emission as shown here ranged from twenty to sixty percent --- that's during the deceleration cycle.

Before our development work was completed, road test data became available which indicated the deceleration cycle contributed not much over thirty percent of the total driving emissions, although the estimate made at the beginning of the effort was that the deceleration cycle contributed sixty percent. On that basis we concluded that a device with a sixty percent efficiency, working on a deceleration cycle that caused only thirty percent of the emission, could result in only an eighteen percent overall reduction of hydrocarbon emissions.

These facts, along with a representative group of samples of the devices, were provided to the Los Angeles Air Pollution Control District in 1957. After analysis and evaluation, the District concluded that it would take no further action. We have on display a model of throttle-control device, the vacuum control throttle limitor. Thank you.

MR. HEINEN: Thank you, Mr. Burke. The second device to be discussed will be the low temperature catalyst system. Mr. Chandler, Vice Chairman of our Committee, will discuss that particular device.

MR. JAMES H. CHANDLER: Mr. Chairman, gentlemen --- the catalytic converter is one of two approaches for removing unburned hydrocarbons from automobile exhaust gases, the other approach being the non-catalytic afterburner. Both of these devices remove the unburned hydrocarbon by burning them with additional air which is added to the exhaust gases.

A catalyst is a substance which accelerates a chemical reaction, but remains essentially unchanged after the reaction takes place. In the low temperature catalytic converter, a catalyst such as

vanadium pentoxide is arranged in a container which replaces the standard car muffler. The exhaust gases coming from the engine and an extra supply of air react in the presence of the catalyst to burn the unburned hydrocarbons to completion. Slide I shows a cut-away drawing illustrating the catalytic converter. Exhaust gases already containing extra air enter the inlet pipe to the left, pass through the screen and the catalyst bed to the outlet pipe. The next slide shows a hand-built prototype catalytic converter installed on a test vehicle with the installation of a standard production muffler shown to the left shown for comparison. The next slide shows the installation of an air compressor on the engine to supply the additional air required directly to the engine exhaust manifold. May I have the lights, please ---

It is estimated that this catalytic converter will remove from sixty to seventy-five percent of the unburned hydrocarbons in exhaust gases during normal traffic operation. During a test with the converter in a smog chamber, average hydrocarbon conversion efficiences of eighty-eight and ninety-one percent, respectively, were achieved for idle and deceleration, and efficiencies of sixty-eight and seventy-four percent, respectively, were achieved for acceleration and cruise.

This particular catalytic converter is only slightly larger than a standard production muffler. For the most part, it also performs the muffling function of the standard muffler although in certain applications additional tailpipe resonators may have to be used. At the present state of development, catalyst life is estimated at between ten and twelve thousand miles of driving when leaded gasoline

is used. Under certain operating conditions, such as warm-up and when the catalyst is no longer active, unpleasant exhaust oders can occur.

At the present time this low temperature catalytic converter system is undergoing evaluation testing to determine its operation under a wide variety of driving conditions. The system in its present form, of course, is handbuilt. Since extremely high temperatures might harm the catalyst material, the need for a high temperature by-pass to allow the exhaust gases to by-pass the converter under extreme heavy duty operation must be determined by additional testing.

A test car with a catalytic converter has been driven to Sacramento from Detroit for your inspection as part of a durability test trip. The car will be driven back to Detroit, and the effect of the extended road mileage on the catalyst will be checked in the laboratory in Detroit. I would like to go down to the table now and show you some of these devices.

I wanted to show this as a standard muffler, to give you some concept of the size of these devices. This is a low temperature catalytic converter. You can see inside some of the vanadium pentoxide pellets. Normally, the bed is completely full of catalyst materials. Over on my left, which I am blocking on the table, is the same type of converter completely insulated in a temporary form before --- it hasn't been developed for production yet --- insulated for car installation --- and here is the air compressor which is attached to the engine to supply the secondary air. Thank you.

MR. HEINEN: Thank you, Mr. Chandler. The third, or high temperature catalytic device will be discussed by Mr. J. M. Campbell of General Motors Corporation. Mr. Campbell.

MR. JOHN M. CAMPBELL: Mr. Chairman, ladies and gentlemen, the purpose of my report is to describe tests which have been made to determine the effectiveness of a particular catalyst which has been prepared by the Oxy-Catalyst Corporation of Wayne, Pennsylvania. Because of Dr. Eugene Houdry's association with the development of this catalyst by the Oxy-Catalyst Corporation, this catalyst has been identified as the Houdry Catalyst. Previous catalysts developed by Dr. Houdry have contained precious metals, such as platinum and palladium, and they were quickly inactivated in use with gasolines containing compounds of lead, sulphur and phosphorous found in gasoline. However, this particular catalyst, which has been used in these tests, did not contain precious metals, and was resistant to the inactivating effects of lead, sulphur and phosphorus compounds. The catalyst, as employed for purifying automotive exhaust gas, is mounted in a container called a converter, shown in this slide. You see, this is very similar to the converter shown by Mr. Chandler, the previous speaker, and I will not take any more time to describe its operation. May I have the lights, please.

The efficiency of this catalyst as mounted in this particular unit varies with the temperature of the catalyst bed and with the number of service miles. At 10,000 miles of service the catalyst was found to be about 80% effective in removing hydrocarbon. At 20,000 miles its effectiveness had fallen off to about 30%. Our experience has indicated that the catalyst will need to be replaced or reactivated after about 12,000 miles of service.

Now this catalyst by itself does not affect oxides of nitrogen. However, tests have been conducted using the Houdry catalyst on a car equipped with a modified carburetor with the carburetor adjusted to run somewhat richer than the ordinary adjustment to provide for reduction in the oxides of nitrogen and with the Houdry catalyst to take care of the reduction in combustibles. This test of the two combined units gave up to 90% reduction in both oxides of nitrogen and hydrocarbons but at a cost of about 25% increase in gasoline consumption. There remains a number of difficult problems to solve before we will have a unit that could be recommended for use by the public. Among these are reduction in cost, weight and size; (2) better control of noise, odor and excess heat; and (3) the development of automatic control mechanisms for adjusting air admission and exhaust by-pass; and (4) the reduction of the catalyst warm-up time and loss of catalyst in service. We now have a vigorous engineering program in progress to solve these problems. This work has already given us some promising results, and some of these improvements have been incorporated in the cut-away exhibit which we have over here on the table on the right. A similar unit is installed in a test car which we have on exhibit downstairs. Thank you very much.

MR. HEINEN: The last report from our Committee is on the noncatalytic after-burner. Mr. A. K. Caldwell, Vice President in Charge of Engineering and Research from Thompson-Ramo-Wooldrige will discuss this type of device. Mr. Caldwell.

MR. A. K. CALDWELL: Mr. Chairman, gentlemen of the Legislature, it is a privilege to present to you the Thompson-Ramo-Wooldrige automotive exhaust device to control emission. It is also a privilege for me to be here, being a rare individual who is a native son of Calif-

ornia from the Auburn area many years ago. You might wonder why we were working on such a device. As a part and component service to the industry, we work on new things, we work to improve the old things, and many contributions have come from us, and from other parts makers in the industry. We must do that to live --- these folks are our customers, and we are a part of this industry.

Several years ago, the Air Pollution Foundation of Los Angeles approached our affiliate, Ramo-Wooldridge, to talk about the smog problem. At that time we had no answer, but one of our nuclear physicists, a Dr. Stuart Ridgeway, who is here today, started thinking of this problem, and he came up with an idea that seemed feasible enough to us to build a prototype and test it. With the help of the Air Pollution Control Board and the District Control Board we did evolve a satisfactory prototype. We spent several thousand dollars in doing this, but if there is a problem in the industry, we are part of the industry, and we would like to help all of it we can. This device was shown later to A.M.A. and also shown to the folks in Los Angeles. The idea is not new, but there are new details which make this device operable, whereas some former devices using the same idea did not work out as well.

I would like to tell you very briefly how the device works, if I might have the first slide. You will note that the exhaust gas with an air supply added to it goes through a heat exchanger into a combustor at the rear of the device where it is burned. The reason for the heat exchanger is to bring the exhaust gas to a temperature which will support combustion. The heat then goes back through the heat exchanger to heat the exhaust gas which is coming in, and then

the exhaust goes through the tailpipe, as you see. To control temperature, there will be an automatic control on the device and you will see a by-pass. When the temperature becomes too high in the combustion chamber, the heat exchanger is by-passed and the exhaust goes directly into the combustor. There is an air pump which supplies air to the device.

The next slide, please ---- This is a picture of the prototype device. You see the air pump at the front, the exhaust with the by-pass going to the rear, and one of our devices is on the table here. This device is a good muffler, it could replace the muffler, and the temperature, as it has been insulated, is lower than the temperature of the muffler on a car.

The next slide, please ---- This is Dr. Ridgeway under the car, and there is the prototype device. You can see the exhaust line going to the rear of the device, the combustion chamber is at the rear, the heat exchanger is at the front, and you will see the controls in the by-pass just above his hand.

The next slide, please --- This is an artist's conception, looking at the car, showing the various parts of the unit. The air pump in front in green, the control there in blue, the after-burner in red, and possibly another muffler or resonator to be used at high speed. Now, all engineering devices are compromises. In this particular case we might have to compromise, the compromise being weight, size, the performance required, and the cost of the device. Above 60 miles an hour to keep the device small, we may wish to pass the exhaust through an ordinary muffler and on out. We just don't know at the moment whether that is necessary or not. My own idea is that if we

have to by-pass it above your speed limit, that the minute that came on the driver and everybody else would know that he was above the speed limit. It might be a good idea to leave the muffler off.

The car I showed you just before has been driven some 1,200 miles with the device in operation -- it was driven back to Detroit, driven back here -- the device was not on all the way because we were pressed for time, but there has been 1200 miles of operation with the device, plus the work that has been done in our laboratory, plus the work that was done in the smog chamber at Stanford Research, and the eye irritation in that smog chamber was very greatly reduced by the use of this device. We may say that our experimental work shows that we can take 90% of the unburned hydrocarbons out of the exhaust. We have had a number of tests which show that result.

The next slide, please. Here is a phantom view, an artist's conception of a 1959 car where this would replace the muffler -- and you can see the installation at about the position where the muffler would go. The unburned hydrocarbons are burned to carbon dioxide and to water. This device as it is now designed is effective at about sixty seconds after the engine is in peration. It is made of stainless steel, and the temperature in the combustor is around 1500° to 1550°, but is so insulated that the temperature of the device is not greater than the temperature of the ordinary muffler on the car. The controls and the air pump would have to be given periodic inspection to see that they are in good operating condition. This is in the prototype stage, there is a considerable amount of work that has to be done yet, but we have proven the principle that if the unburned hydrocarbons are the cause of smog, 90% of those unburned hydrocarbons can be eliminated with this device. Thank you.

MR. ACKERMAN: Gentlemen, this concludes our presentation. We think we have demonstrated to you the concern we have had with your problems and our problem, and described our work in the field of hydrocarbon and nitrogen oxide control. All of us wish that there could be a simple answer to all of this, but smog isn't a simple problem. We are encouraged by the progress that we have made in this very difficult and complex area. The automotive industry now knows how to reduce substantially vehicle exhaust gas emission, and we have experimental devices that do that job. These devices show promise that they are like new cars in the development stage. They are working, but they need a lot of improvement before they can become available for general use. Choosing for final engineering any of the several devices now undergoing test and development can be done in line with the requirements for such a device formulated by the Los Angeles Air Pollution Control District. A key question in selecting a device is: how effective do you want it to be in eliminating hydrocarbon? Sixty, seventy, eighty, possibly ninety percent? In order to develop the most economical type of device and bring it within a cost range most acceptable to customers, we need specific guidance of local officials on the percentage of exhaust clean-up required. Their answers will also determine, to a great extent, the size, frequency of replacement, and other characteristics of the device.

We in the industry assure you that we will continue to devote our engineering efforts toward devising the most efficient methods and systems to reduce hydrocarbon at the lowest possible cost. Our progress to date leads us to present for your consideration the three-step program to reduce air pollution in Los Angeles as outlined earlier by

Mr. Chayne. The first thing would be the setting up of vehicle inspection procedures under official jurisdiction. The second step would be to put existing vehicles in Los Angeles into proper mechanical condition. The third step would be the installation of exhaust control devices when the Pollution Control Districts find them suitable for use in accordance with their predetermined standards.

As you can see, it is not our intention to come here and claim an easy solution. The execution of each of these steps requires formidable efforts in order to achieve the goal of reducing hydrocarbon emission in the automotive vehicle exhaust. On behalf of our industry, I pledge to you that the members of the Vehicle Combustion Products Committee will continue to spend maximum time and effort on smog problems. This Committee is responsible for carrying out the industry's smog research programs, and it represents the industry on this entire problem. It will continue to cooperate fully with you in their work, and I know it will welcome your continued cooperation.

Now, we are very grateful for having the opportunity to present this story. We realize that it has taken a great deal of your time, and we are gratified that this subject is of sufficient interest for you men to sit here and listen to a rather long and complicated story. If there had been a simpler way of telling it to you, we would have done it. As I said earlier, we tried to anticipate the questions that would come up on this subject. We did our best to answer them with the data that we presented here today. Now, we have cars -- have cars in the basement that show these devices. We certainly would like to have you come down and look at them. We have men there that will explain them in detail, and while we may have answered most of the ques-

tions, if there are any others, we will certainly do our best to answer them.

ASSEMBLYMAN BACKSTRAND: Yes, I have one question. Nearly all your references have been made to hydrocarbon emissions. My second question relates to: is it a fact that oxides of nitrogen are also a problem as an air pollutant?

MR. ACKERMAN: Yes, it is.

ASSEMBLYMAN BACKSTRAND: Alright, now, my next question, -- your chemist could probably answer this, or perhaps you know -- do oxides of nitrogen come from automotive exhausts, or not? I know that we have had some testimonies that the burning of natural gas can also produce some oxides of nitrogen. I was wondering -- in other words, what I was getting at, if oxides of nitrogen are a part of the problem, do these devices also correct that situation?

MR. ACKERMAN: You have referred principally to hydrocarbons. Is it possible for these devices, by eliminating hydrocarbons, to eliminate both the hydrocarbons, the unburned hydrocarbons and the oxides of nitrogen to put a bigger load on the after-burner or the catalyst muffler? Now, the two in combination, according to the theory, are smog-producing elements in the presence of sunlight. However, if the oxides of nitrogen themselves, it would have to be from emission. If there is a chemist here who challenges that, will he challenge it now?

ASSEMBLYMAN BACKSTRAND: Thank you very much.

ASSEMBLYMAN LEVERING: I presume that all of us are familiar with the equipment that is necessary to properly analyze the tune-up of motor vehicles from the standpoint of performance. Now, my question is this: if we're going to have to ultimately get into the analyzing of

the exhausts to determine the amount of hydrocarbon emission from those exhausts, do we have equipment that would now measure that, and if we don't, how much would it cost to get that equipment? How much will it cost to train the manpower? I think we should know something about what tools are necessary for going into that short of a program; would we have to use dynamometers, etc., in order to make complete tests? Can you comment on that subject, or do we have no information?

MR. ACKERMAN: We do have equipment that analyzes exhaust gas. This is not equipment that in its present state would be suitable for wide installation in inspection stations. That equipment can and would have to be developed. I wouldn't want to offer any figures on what the equipment would cost, but I will say this --- we say that it's perfectly practical and that, in the ordinary inspection procedure, specifications would be worked out so that it would be pretty much of a routine check. We have estimated that it may be from ten minutes to certainly not more than an hour to make the check. And I believe those were the figures that Mr. Raviolo was using when he made his estimate of the number of stations required. Does that answer your question?

ASSEMBLYMAN REES: Are you familiar with Governor Brown's Air Pollution Program, which was introduced in the Legislature last week?

MR. ACKERMAN: I am personally not familiar with it.

ASSEMBLYMAN REES: The program was to direct the Department of Public Health to go into and later establish minimum standards in terms of automobile exhaust. It was the minimum program. It merely asked them to study and then publish the findings as to what they considered to be the maximum levels in terms of public health for automobile exhausts. Another bill would have called for the Department of Motor

Vehicles to begin study about setting up compulsory inspection stations. Would you feel that this would be a program that your industry would support?

MR. ACKERMAN: I would like to comment this way -- we feel that it is going to be essential for the regulatory officials to determine to what extent they want the device to reduce the hydrocarbon emission.

ASSEMBLYMAN REES: Then you feel that the Governor's program was a good program towards getting along on this problem.

MR. ACKERMAN: Well, I believe that it is not in conflict at all with the work that we're doing in Los Angeles; that is one of the questions that we have asked -- what is the extent to which the exhaust must be cleaned up, and if that were included in the program of the Governor, I would say that we would be in accord.

ASSEMBLYMAN REES: Do you plan to spend more money and increase your present research program? I remember that in November at the National Air Pollution Conference many people thought that you were dragging your feet in terms of putting together a strong program. They felt that you should be spending more than one million dollars a year, which I understand is your present expenditure.

MR. ACKERMAN: I would say this -- that our research program at Quincy is handicapped by the lack of money, but not even an unlimited expenditure would make a break-through that we might get from a few extremely conscientious investigators to find a catalyst or an approach to the problem that we haven't seen in the past.

ASSEMBLYMAN REES: Do you plan to continue the same program that you have at present?

MR. ACKERMAN: As we stand now, having now three devices that we feel offer promise, we will greatly expedite our work because now it becomes more of a mechanical job rather than an analytical and a research job. We will take these devices now and bring them along to where we feel they will do the job, where they are producible and where we can build them at the lowest possible cost to the vehicle operator.

ASSEMBLYMAN REES: Then this can't be accelerated in any way by putting in more funds and effort?

MR. ACKERMAN: We would say not. At the moment we are getting additional units built. They will be built in whatever quantities that are required, and they will go on to an extensive test program, and right now in many of these cases just plain time is required, and it will take time to prove these devices, prove that they're durable and effective, and they have no adverse effect.

ASSEMBLYMAN REES: Thank you. In your testimony - the first two papers - you alluded to the problem as being primarily a Los Angeles problem. Do you think that your Committee will start to consider this as a state, regional and national problem, especially from the results of the National Air Pollution Conference of last December, where people from all over the nation came and testified that they were having air pollution problems?

MR. ACKERMAN: I would say this, that the reference to this being a Los Angeles problem is one that was more or less common usage. We don't, we didn't imply that it is solely a Los Angeles problem. Our exhausts emit probably just as much unburned hydrocarbon in other atmospheres as in Los Angeles. So that I would say this - any device that was effective in Los Angeles certainly could be used on a national scale.

It could be used in any community where this was a problem. If it is true that if the requirement in Los Angeles is 90% clean-up, in some other area it might only be 60% clean-up, but, as far as we in the industry are concerned, we feel that wherever the exhaust emissions create a local problem, we would say this device should handle it equally well.

ASSEMBLYMAN REES: Don't you feel the regulation would have to be based on a large area, such as the state or federal legislation, --- otherwise, it would foul you people up -- you can't make an automobile for every little city in this country.

MR. ACKERMAN: Well, I would say that it is not uncommon to try a specific device. We use maybe heavy-duty tires in certain areas of the country and equip the cars with heavy-duty tires where road conditions are such that they are needed; so it wouldn't be an unsurmountable problem to equip cars at the factory with this device in whichever areas the device is required.

ASSEMBLYMAN REES: Isn't it a lot more profound problem, one that involves the complete engineering of a car, than one that just involves tires; don't you think that we're going to get around eventually to the time when every car will have devices on it? That this is a national-wide problem?

MR. ACKERMAN: Frankly, we don't think so. We think that it is a problem that is more severe in certain localities.

SENATOR RICHARDS: The report that was submitted by Mr. Ackerman has, as the first item of the concluding recommendations, the setting up of vehicle inspection procedures. Following upon one of the prior questions, when you were asked about that subject, it was indicated by

the questioner that we do not yet have uniform devices for testing insofar as the degree of exhaust pollution is concerned. I believe that one of the factors contained therein was your request that you receive from us, to-wit, I assume from the State of California or from the locality bothered therein, a standard that we would want to have met. For example, 90% clean-up. Therefore, based on that, may I ask if our Department of Health were to come up with a conclusion, let us assume now arbitrarily, 90%, to be effective, and if we were to establish motor vehicle inspection stations in the State of California, could we look for the automobile industry and to your research teams for the furnishing to us of information and the engineering know-how for the establishment of the testing methods, mentioned here by Assemblyman Levering, for example, in his question --- in other words, we don't have that, where are we going to get it? Can we look to you for it?

MR. ACKERMAN: Yes, you certainly may. That was the problem in the early stages. I would say that a great deal of progress has been made. I believe the Los Angeles officials and the industry now talk the same language and get substantially the same results from their checking. So, I would say 'yes' --- we would be happy to work with you people in developing instrumentation that could be used and be relied on to give uniform results. It is a problem, but we are certain that it is one of the lesser problems in this whole subject.

SENATOR RICHARDS: Thank you. And, in another field, others may not be confused, but I am, as to the degree of the industrial specific participation in the development of these after-burner catalytic devices. For example, the Rheem Manufacturing and Curtis-Wright, G. E. and International Harvester, and others, outside of the automobile in-

dustry are working on this kind of research; included within the report that you have given us are Ramo-Wooldridge and Houdry and the Ford device. Now, in the instance of the Ford device -- I assume that is directly, and in and of itself, a product of the research of your research team. In the case of Ramo-Wooldridge and Houdry, these are, I understand it, outside agencies that have submitted to your team their device for testing. Is that right? What I am trying to understand is, as we watch this proceed and look for improvement, do we look specifically to the research team which is here and the people you represent as a unifying organization to pull together the information which is available both from private and from your own sources, that is, external and interral, or do we have to set up the kind of coordination which would then give us in one part information we get from you, in another part information we get from Houdry, in another part information we get from General Electric?

MR. ACKERMAN: I think it would be very well for all agencies working on this problem to look to our Committee. We are examining all devices, regardless of their source, that appear to have any likelihood of aiding in the solution of this problem; therefore, any devices in which you might be interested, or you have heard of, or any agency that you think could contribute to this problem, we are encouraging them to contact this Committee where the device will be screened. And if the work has to be done, it will be assigned to the various participating companies -- we believe that in that way we can get results much faster. We feel that we know more about our business than other people, and we are used to working with these suppliers, and our relations with them, I would say, are very good. In general, I think this would expedite the

development of a useful device greatly if it were handled through those channels.

SENATOR RICHARDS: And is it a correct understanding that in the work you are doing, for example, on the Ramo-Wooldridge and Houdry devices, that you not only test what they give to you, but I take it you apply your engineering know-how for the improvements which are incorporated as you find them in the device itself?

MR. ACKERMAN: That is certainly true of the Houdry device at the moment, and I think it will shortly be true of the Ramo-Wooldridge.

SENATOR RICHARDS: And, lastly, with respect to each of these devices, which has thus far been developed, your thought is that the difficulty is that, depending upon the degree of their effectiveness, they are either too big or too expensive in terms of production to ask the people as of now to apply them. For example, about $200 in the case of Ramo-Wooldridge, I believe is the estimated production cost, or roughly that, and in the Houdry case it is a lot cheaper, about $60.00, but you have additional cartridge additions. If that figure is wrong, by the way, because I didn't hear the figures except as a separate source, I would like to have it corrected, and since I see a gentleman raising his hand, I wonder if I could interrupt right now to ask. Can we get estimates, or can we get from you, or whoever can give it, the estimated cost of the three devices in terms of what they would cost the consumer when they reach production. If you can give that to us, together with the estimated cost of the renewed packing which would have to be applied in the case of a catalyst every 10,000 or 12,000 miles?

MR. ACKERMAN: I don't believe anyone could give figures that would be very reliable in those areas at the present time. There have been estimates made on the layouts to be made and the engineering design studies to be made, but I think you will find in the history of our industry that these devices which, at this stage look pretty expensive, by continued development and work with them, are reduced in cost considerably. I wouldn't want to give the impression, while at the moment all that we can tell you is the fact these devices now look expensive. I am sure that by the time we know what we have, what the problem is, what we have to do, and learn how to make them, that there will be reasonable reductions in these figures that are being quoted now merely so that we have some way of evaluating.

SENATOR RICHARDS: Thank you, and, then, lastly, may we assume that someone in the industry would not only develop a device efficient in its operation, in terms of the 90% in reduction of pollutants, but one which is both small enough and practical enough and cheap enough so that we can ask for its application on automobiles.

MR. ACKERMAN: That is certainly our objective. Mr. Chayne.

MR. CHAYNE: The two matters on which I would like to comment, and I will take them in reverse order, first, in answer to the latter question about the price of the Houdry unit. The unit you see over there was built by Houdry. It is strictly a handmade job, it is not designed for production in the scale that Los Angeles will require it, there are no controls on the air intake, and that will be required. It also requires mufflers on both the air intake and the exhaust system in back of that. It requires an exhaust pipe that is about one and one-half times the size of the normal exhaust pipe on the car. So, I would say this:

that the story that was brought back to the West Coast regarding the approximate cost of the Houdry muffler, and also the price that General Motors paid for the license, the two figures are about as far off, but in the opposite direction.

Now, the other thing, Mr. Ackerman, that I would like to comment on: I think that I detected in the background of some of these questions about our development work a thought that was bothering somebody that perhaps we were going to pull off the fellows who have been doing this development work and make them do the development work on these mufflers, and the research in the background was not going to continue. I think I can tell you for the industry that as these experimental jobs move into the production engineering stage, that our research people are going to continue their work, exploring the basic fundamental fields and trying to come up with new catalysts, trying to come up with new after-burners, and above all, trying to find out why the engine has to have an additional gimmick on it to clean up what it blows out into the air. That, fundamentally, is the job that the industry has yet to do. We don't have the slightest idea at the moment how to do it, but we are trying to find out. That's all I have to say, gentlemen.

MR. ACKERMAN: Thank you. Are there any further questions?

SENATOR RICHARDS: One more, and that others may know the answer too. I am not familiar, or not sufficiently informed as to the degree of cooperation that exists between the automobile industry per se and the oil refining industry per se as to who, in other words, scratches whose back. If we may assume that, as automobile engines progress in their refinement and their horsepower and their efficiency, it is the job

of the oil-refining industry to create fuels which service those demands. May we then, if that is correct -- and I don't know if it is -- assume that the automobile industry is in a position to utilize their influence, and that they would utilize their influence, in conducting correlated research and attempting to get correlated answers so far as fuel components are concerned as they contribute to the air pollution problem?

MR. CHAYNE: I am sure that that is done to a much better extent than is generally understood through the Coordinating Research Council -- we work very closely with the petroleum industry, and I would say our working relationships are very good and very close. I would state that any suggestion on our part, so far as fuels are concerned that would contribute to the alleviation of this problem, would be undertaken jointly between the petroleum and automotive industries without question.

ASSEMBLYMAN RUMFORD: Are there any additional questions? If not, Mr. Ackerman and Mr. Raviolo and Mr. Chayne, we are grateful to you and the team that came to the seat of things here at the Capitol. I think you have gleaned the intensity and the desire on the part of the Legislature to do its utmost to insure that we have acceptable air in California and throughout the nation. We can only do so much legislatively. We are depending upon you and the great facilities that you have as far as engineering is concerned. We feel this is an important problem to the health of the people, and presents a clear and present danger. With those few words, I should like to remind you that the papers presented here are in your post office box, and that the automobiles are in the garage for exhibition purposes and demonstration, and again we thank all of you for participating.

The meeting is adjourned.